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ORNIX PRUNIVORELLA CHAMBERS (LEPIDOPTERA, TINEIDAE), A PEST OF THE APPLE TREE IN THE LOWER MISSOURI RIVER VALLEY REGION.*

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Introduction

The existence of a leaf-mining insect in the Kansas Agricultural Experiment Station orchard at Manhattan was the reason for the investigation of this problem. Later the damage of this insect was found in the apple growing region of North-eastern Kansas. Since the specific insect was unknown at the beginning of the work, three objectives were set forth as follows: (1) to determine the insect or insects causing the damage, (2) to study the biology of the insect or insects, and (3) to find an effective means of control. The insect was later determined as **Ornix prunivorella** Chamb.

Economic Importance

This is one of many insects of secondary economic importance. Infestations of a serious nature occur sporadically and are usually of importance for only a few years. The larvae injure the foliage by feeding between the epidermal layers of the leaf.

Historical Considerations

Most of the papers dealing with this insect are short and have been written about one phase, such as, habits, description, taxomony or control of **Ornix prunivorella** Chamb. Probably, the most valuable paper on life history of this insect for the Lower Missouri River Valley Region is that of Haseman (1916).

Distribution

This insect has been reported from the following states: Packard (1869), New England group; Forbes

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(1887), Michigan, Illinois; Chambers (1877), Colorado; Brunn (1883), New York; Chambers (1873), Kentucky; Gossard (1911), Ohio; Haseman (1911), Missouri; Luggar (1899), Minnesota; Ross and Caesar (1920), Niagara districts and Norfolk county in Ontario, Canada; Severin (1922), South Dakota and Arkansas besides being reported by the authors for Kansas. No reference was found that dealt with its life history or habits under Kansas conditions.

Larvae of this insect were first collected west of Manhattan, Kansas, at the Kansas Agricultural Experiment Station Orchard in 1933, also in the summer of 1934, near Ogden in Riley county, Kansas and during the summers of 1934 and 1935 in the vicinity of Eskridge, Kansas. During 1934-35, larvae were collected in the vicinity of Troy and Wathena in Doniphan county, Kansas. In Doniphan, Atchison, and Leavenworth Counties it was present in 1936, and during 1937 it caused serious damage.

Synonymy

This insect has several synonymous, scientific and common names. Dr. Annette F. Braun, University of Cincinnati, Cincinnati. Ohio, determined the reared insects to be **Ornix prunivorella** Chamb.

The accompanying Table 1, shows the different scientific and common names that have been used in the literature in relation to this insect.

Hosts

Although the leaves of several species of fruit trees are attacked by **Ornix prunivorella** Chamb., this paper deals especially with the infestation on apple trees **(Pyrus malus)**. Apple trees are by far the favorite host of **Ornix prunivorella** Chamb. All of the varieties (62) of apple trees in the Kansas Agricultural Experiment Station orchard were found to be infested (a list of these are on file in the Department of Entomology). All varieties of quince **(Cydonia ablonga)** and pears **(Pyrus communis)** grown in the Kansas Agricultural Experiment Station orchard, were found to be heavily infested. Infested leaves were also found on the sour cherry **(Prunus cerasus)** and seedling cherry stock **(Prunus mahaleb)**. No infested leaves were observed on sweet cherry **(Prunus avium)** or cultivated plum **(Prunus sp.)**.

Table 1

Synonymy

Ornix prunivorella Chambers

Table Showing Inconsistencies of Nomenclature in the Literature

Scientific Name	Common Name	References	Remarks
Lithocolletis geminatella Pack.		Packard (1869)	Original description.
Ornix prunivorella Chamb.		Chambers (1873)	Original description by Chambers.
Ornix prunivorella Chamb.		Walsingham (1882)	On two species of **Lithocolletis geminatella** Pack.
Ornix prunivorella Chamb.	Unspotted Tentiform Miner of Apple	Brunn (1883)	Life history and habits in New York.
Ornix prunivorella Chamb.	Apple Leaf Creaser	Weed (1888)	On synonymy **Ornix prunivorella** and **geminatella** same.
Ornix geminatella Pack.	The Apple Ornix	Forbes (1889)	Notes on life history and habits of insect.
Lithocolletis geminatella Pack.	Pear and Apple Tree Leaf-Miner.	Luggar (1899)	Notes on habits of insect.
Ornix geminatella Pack.	Wild Cherry Leaf Miner	Luggar (1899)	Notes on habits of insect.
Ornix geminatella Pack.	Pear Leaf Miner	Gossard (1911)	Notes on infestation of apple and pear in Ohio.
Ornix prunivorella Chamb.	Spotted Tentiform Leaf Miner	Haseman (1911)	Notes on infestation and report.
Ornix geminatella Chamb.	Unspotted Tentiform Leaf Miner	Haseman (1916)	Life history study.
Lithocolletis prunivorella Chamb.		Haseman (1916)	Paper on **Ornix geminatella** Pack.
Parornix prunivorella Chamb.		Forbes (1923)	**Parornix prunivorella** Chamb. and **Parornix geminatella** Pack. are listed as doubtful synonymy
Parornix geminatella Chamb.		Forbes (1923)	
Parornix		Leonard (1926)	Classification of Hubner in "Tentamen."
Parornix prunivorella Chamb.		Needham - Frost-Tuthil (1928)	Account in book devoted to "Leaf Miners".
Ornix prunivorella Chamb.	Unspotted Tentiform Leaf Miner		Identification of insect by Dr. Annette F. Braun in 1934.

Character of Injury

Pear (**Pyrus communis**) leaves examined showed that little of the tissue forming the palisade cells had been eaten by the larva, however, the lower epidermis covering of the mine was frequently dark brown or black color. All apple trees were heavily infested. The ones having large succulent, hairy leaves that send out vigorous new growth were likely to be more heavily infested than trees having thin, shining, leathery leaves that send out little new growth.

In the early stage of making the mine, the larva feeds between the epidermis and eats the mesophyll cells and tips of the palisade cells, thus constructing its mine and removing all tissue within, leaving only the upper and lower epidermis to form the mine.

Leaf burning was found after the application of the arsenical sprays. It is the contention that extremely high temperatures, lack of moisture, and arsenical spray residue are the factors that cause the burning of the leaf around the insect mine. When these factors were not present which affect the physiological condition of the leaf, this kind of burning was not observed.

Methods and Procedure

Several different insecticides were used during the season of 1933. The experimental plots were selected for research in the codling moth (**Carpocapsa pomenella L.**) control insecticide test plots.* Drought conditions prevailed this year in Eastern Kansas.

On the several plots the following stomach poison insecticides were used at the rate of 3 pounds to 100 gallons of water: astringent lead arsenate, non-astringent lead arsenate, manganar (manganese arsenate), Dutox (barium fluosilicate), and Kalo (sodium alumninum fluoride). Calcium arsenate was used at the rate of 2 pounds plus 2 pounds of lime. The first 3 cover sprays in the manganar, Dutox and Kalo combinations were non-astringent lead arsenate.

In another set of plots were used the contact insecticides. These were combinations of lead arsenate, used

* Thanks are due to Dr. Geo. A. Filinger of the Horticulture Department for the cooperative use of spray data and to the Department of Horticulture for the use of the Kansas Agricultural Experiment Station orchard.

for the first 3 cover sprays and at the rate of 3 lbs. to 100 gallons of water, and organic compounds for the remaining 4 cover sprays. The mixtures were made up on the basis of 100 gallons of water. The 3 organic compounds used were 40% nicotine sulphate 1 pt. plus summer oil emulsion (Verdol) 1 gallon, nicotine tannate (40% nicotine sulphate 1 pt. plus tannic acid 3 pts.) and oleic acid 1 pt. plus summer oil emulsion (Verdol) 1 gallon. Following the calyx spray of lead arsenate there were seven sprays applied to all plots. The first cover spray was applied between May 1 and 6; the second, between May 15 and 22; the third, between May 30 and June 2; the fourth, between June 26 and 28; the fifth, between July 11 and 12; the sixth, between July 31 and August 1; and the seventh, between August 19 and 26.

Leaf counts were made to determine the effectiveness of using stomach poison and contact insecticides as shown in Tables 2 and 3.

RESULTS OF EXPERIMENTAL WORK

Biology of Insect

Leaves infested by larvae of the insect were found in June, 1933 at which time the biological work began.

The cylindrical, fine meshed, copper wire, insect cage (Plate 1, Figure 7) was quite satisfactory for life history work. Two adult moths emerged from two of these cages that were placed in contact with the ground and with the soil covered with fallen leaves (Plate I, Figure 9). The insects emerged April 7, 1934. A successful type of cage for rearing larvae was a paper sack with a moist cloth or sponge placed inside with the infested leaves. The most successful type of insect cage for carrying the insect through the winter, was the upright glass cylinder that was placed several inches into the soil and had the top covered with muslin (Plate I, Figure 8).

Life stages

Egg

Plate II, Figure 7 shows a magnified drawing of the egg. Its size varies from 0.254 to 0.4 mm. in length and from 0.18 to 0.29 mm. in breadth. The eggs are laid singly on the under surface of the leaf, but it appears that no particular spot is chosen to receive the egg.

On August 27, 1933, 15 adult **Ornix** moths were placed in a 4-inch glass vial. On September 3, the embryonic larvae were apparently ready to leave the shell and could plainly be seen curved inside the egg shell (Plate II, Figure 9).

Larva

Plate II, Figure 10 shows the newly hatched larva which is footless. In its development it passes through four district instars. When the larva is full grown it is 6 to 7 mm. in length. The head is light brown and the first thoracic segment is light yellow· besides having 4 characteristic black spots. Plate II, Figure 12 shows it as a gray caterpillar which has conspicuous white tubercles on the body and six thoracic legs besides abdominal legs.

The Mine and Larval Life

The newly hatched larva makes a serpentine mine (Plate II, Figure 1). This mine goes through a transition which corresponds to the changes of the 3 larval instars (Plate II, Figures 10, 11, 12). This serpentine mine averages from 4 to 10 mm. long. The blotch mine is evident about the time the larva changes to the second instar. This appears on the under side of the leaf and the epidermis is loosened from the palisade cells by the feeding of the flat footless larva. This loosened epidermis soon dies and turns brown. After the blotch is formed the larva starts feeding at one end of the mine, consuming the palisade cells and all tissue between the lower and upper epidermis. There are no green spots, caused by the remaining of part of the tissue of the inner leaf in the insect mine. This habit is responsible for the descriptive part of the common name which is "unspotted".

The larva produces the tentiform mine by spinning silk threads on the floor of the mine which causes the lower dead layer of the leaf to become folded lengthwise of the mine. The larva usually leaves the mine by an opening in the under surface and either prepares a cocoon in which to pupate on the same leaf or goes to a different one. During midsummer, the larval life in the mine is about ten days to two weeks.

Pupa

The mature larva transforms into a pupa which is about 5 mm. long. The color varies from light yellow to

dark brown as the time approaches for it to transform into the moth (Plate II, Figure 14).

Adult

The adult moth is a striking little creature after one has become acquainted with its characteristics and habits (Plate II, Figure 16). To the naked eye, the moth is slate gray with a light tinge of brown, (Plate II, Figure 15).

Life history

Data collected indicate that this insect over-winters in both the larval and pupal stages. The fourth instar larvae were observed in insect cages in the field as late as February 15, 1934.

Adult moths emerged in rearing cages on April 7, 1934. It was about a month later when infestations in the field could be readily found. Six adult moths were placed on a potted apple seedling (Plate I, Figure 10) and in a ten day period from the time of mating, well developed mines were found (Plate II, Figure 6). Mating of the insects was observed in a glass vial on August 2, 1933, the insects joined the posterior ends of their bodies in copulation and remained in this position for approximately 30 minutes.

The following inclusive dates are representative for the beginning of the seasonal broods, for the 1933 season, showing an average length of life cycle of 27 days, with a range of 18 to 35 days: Brood 1—April 5 to 9; brood 2—May 10 to 14; brood 3—June 15 to 19; brood 4—July 12 to 16; brood 5—August 3 to 7; brood 6—August 25 to 29; brood 7—September 12 to 16; and brood 8—October 12 to 16. The large number of broods was undoubtedly due to the warm rains in the fall as green apple leaves infested with larvae were collected in the field as late as December 19, 1933.

Applied Control

Leaf counts were made to determine the effectiveness of using stomach poison sprays and contact insecticides as shown by Tables 2 and 3. Effectiveness of insecticides in the control of the leaf miner is shown by the comparative freeness from insect injury in the various chemical spray treatments. Additional spray chemical injury to the leaves is shown by the burning of leaf tissue adjacent to the leaf miner injury.

Table 2

Relative Burning of Mines by Stomach Poisons per 1200[1] Apple Leaves Infested by **Ornix prunivorella** Cham.

Variety, spray and month, day, and year of examination	Number of Mines			Percent of mines		Average Leaf Infestation in percent
	Burned*	Not Burned	Total	Burned*	Not Burned	
Stayman Winesap Manganar 10-5-33	2952	99	3051	96.76	3.24	2.46 Nine mines found on 1 leaf
Stayman Winesap Manganar 10-5-33	2304	48	2352	97.96	2.04	1.92
Stayman Winesap Manganar 10-5-33	2550	48	2598	98.15	1.85	2.13
Jonathan Astr. Lead Ars. 9-12-33	1500	51	1551	96.71	3.29	1.25
Maiden Blush Lead Ars. 9-12-33	999	177	1176	84.95	15.05	.83
Wealthy Lead Ars. 10-17-33	1359	0.0	1359	100.00	0.0	1.13
Wealthy Lead Ars. 10-17-33	1710	9	1719	99.48	.52	1.43
Rome Beauty Lead Ars. 10-1-33	1337	56	1393	95.98	4.02	1.11
Anoka Lead Ars. 10-5-33	513	252	765	67.06	32.94	.43
Pear Lead Ars. 10-17-33	201	6	207	97.10	2.9	.17
Winesap Kalo 10-17-33	522	9	531	98.31	1.69	.44
Winesap Kalo 10-17-33	982	0.0	982	100.00	0.0	.82
Winesap Dutox 9-28-33	178	11	189	94.18	5.82	.15
Winesap Dutox 9-28-33	234	11	245	95.51	4.49	.20
Winesap Dutox 9-28-33	274	9	283	96.82	3.18	.23
Winesap Cal. Ars. 10-12-33	837	120	957	87.46	12.54	.70
Winesap Cal. Ars. 10-12-33	513	48	561	91.44	8.56	.43

*Burned—leaf mine injury in which spray material has entered and killed additional tissue around the insect mine.

1 In certain instances there is more than one mine per leaf, in one case there were 9 mines per leaf — see percentage of leaf infestation (last column).

Table 2 (Concl.)

Variety, spray and month, day, and year of examination	Number of Mines			Percent of mines		Average Leaf Infestation in percent
	Burned*	Not Burned	Total	Burned*	Not Burned	
Winesap Cal. Ars. 10-12-33	471	72	543	86.74	13.26	.39

Table 3

Relative Burning of Mines by Contact Insecticides per 1200[1] Apple Leaves Infested by *Ornix prunivorella* Cham.

Variety, spray and month, day, and year of examination	Number of Mines			Percent of mines		Average Leaf Infestation in percent
	Burned*	Not Burned	Total	Burned*	Not Burned	
Winesap Nic. Tan 10-1-33	282	18	300	94.00	6.00	.24
Winesap Nic. Tan. 10-1-33	204	8	212	96.23	3.77	.17
Winesap Nic. Tan. 10-12-33	426	15	441	96.60	3.40	.36
Winesap Nic. Sul. + Oil 9-12-33	231	3	234	98.72	1.28	.09
Winesap Nic. Sul. + Oil 9-12-33	138	3	141	97.87	2.13	.12
Winesap Nic. Sul. + Oil 9-28-33	91	17	108	84.26	15.74	.08
Winesap Nic. Sul. + Oil 9-28-33	55	7	62	88.71	11.29	.05
Winesap Nic. Sul. + Oil 9-28-33	69	10	79	87.34	12.66	.06
Winesap Oleic Acid + Oil 10-7-33	405	81	486	83.33	16.67	.34
Collins Oleic Acid + Oil 10-7-33	621	133	754	82.36	17.64	.52

* Burned—Leaf miner injury in which spray material has entered and killed additional tissue around the insect mine.

1 In certain instances there is more than one mine per leaf, in one case there were 9 mines per leaf—see percentage of leaf infestation (last column).

It is noted that the percent of leaf infestation is much greater where the arsenicals or stomach poison insecticides were used, namely, 0.15 to 2.46 percent as compared to that where the nicotine compounds were used, namely, 0.05 to 0.24 percent. Stated in another way, the infestation of leaves which were sprayed with stomach poisons ranged from 1 larva per 7 leaves to 2.46 larvae per leaf. The infestation of leaves sprayed with contact insecticides ranged from 1 larva per 20 leaves to 1 larva per 4 leaves.

It will be noted in Table 3 that the infestation and leaf injury is remarkably less where contact insecticides were used. The 40% nicotine sulphate-summer oil emulsion produced the most effective control.

Biological Control

A number of hymenopterous parasites of **Ornix prunivorella** Chamb. were reared while carrying on the life history studies of this insect. At the time this study was made the infestation at Manhattan, Kansas was at its peak, and the parasites were well established (Plate II, Figures 17 and 18). Seven species of parasites were determined from the collection submitted to Dr. Harold Morrison, Division of Insect Identification, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture. There was also evidence that internal parasites attacked the larvae and emerged from the pupae.

Those parasites identified by A. B. Gahan on June 5, 1934 were:

Elasmus albicoxa Howard
Zagrammosoma multilineata (Ashm.)
Cirrospulus nigrovariegata Gir.
Sympeisis bimaculata Cwfd.
Catolaccus aeneoviridis (Gir.)
Horismenus fraternus (Fitch)
Tetrastichus caerulescens Ashm.

C. F. W. Muesebeck determined the following on March 14, 1934:

Apanteles tischeriae Vier.
Epirhyssalus new species.

Muesebeck (1935) described the above new species in a new genus and species. He placed this new species

that was previously in the genus **Epirhyssalus** in the new genus **Xenosternum.** The species is named **Xenosternum ornigis** Mues. which is also the type species.

Cultural and Mechanical Control

To decrease the number of emerging insects in the spring, disking or cultivating is necessary in the fall or winter. This destroys the pupae in cocoons attached to the fallen leaf or the larvae within the leaf mine. Burning leaves is also a method used to control insects as well as plant diseases.

DISCUSSION AND CONCLUSIONS

The unspotted tentiform leaf miner may infest from 90 to 95 percent of the leaves of the apple tree with from 1 to 9 mines per leaf. In addition to this injury caused by the feeding of the insect is another injury brought about directly by the presence of these insect mines, namely, spray burn.

In years past, this insect has been considered as one of minor economic importance, due probably to the following facts:

1. No insect injury is caused directly to the fruit.
2. Inferior quality of fruit is caused indirectly by damage to the foliage.
3. This insect is heavily parasitized when a serious outbreak occurs and becomes harmful. It is usually checked by its natural enemies within a few years.

Since the sprays in this experimental work were timed and applied for the control of the codling moth, the nicotine insecticides were applied in the last 4 cover sprays, and the nicotine sprays also controlled the leaf miner, it appears that such insecticides applied with or as codling moth control measures will also control the unspotted tentiform leaf miner without additional spraying operations.

More consideration should be given this insect as being one of the harmful orchard pests, especially since stomach poison sprays are of little comparative value for the control of this insect. These sprays caused more injury to the already insect injured foliage in 1933 and 1934 than did the insect. The use of a 40% nicotine sul-

phate summer oil emulsion spray reduced markedly the infestation of this pest. The following combinations are also recommended:

1. Cultural practices such as fall plowing and burning of leaves.
2. Summer spraying with 40% nicotine sulphate summer oil emulsion.
3. Encourage whenever possible, the establishment of the parasites of this pest.

SUMMARY

1. A leaf mining insect infesting apple trees in the Kansas Agricultural Experiment Station orchard at Manhattan, has been determined as **Ornix prunivorella** Chamb. This insect is well distributed in Eastern Kansas.
2. This insect had not been reported from Kansas before November 6, 1933 at which time, Dr. Annette F. Braun of the University of Cincinnati, made the identification.
3. This insect overwinters in both the larval and pupal stages. A life cycle is completed in 4 to 5 weeks during the summer.
4. The larvae of this insect eat the inner leaf tissue and in this way make the mines. Spray materials enter the leaf at points of injured leaf tissue and in this way, cause an additional injury known as spray burn.
5. Stomach poison sprays are of little comparative value in the control of the larval stage of this moth.
6. The use of a 40% nicotine sulphate summer oil emulsion spray reduced the infestation of this pest more than did the other insecticides.
7. There have been reared and identified, 9 different hymenopterous parasites from **Ornix prunivorella** Chamb., one of which is a new species and genus, it being the type species for the new genus.
8. The apple **(Pyrus malus)** is the favorite host plant of this injurious insect.

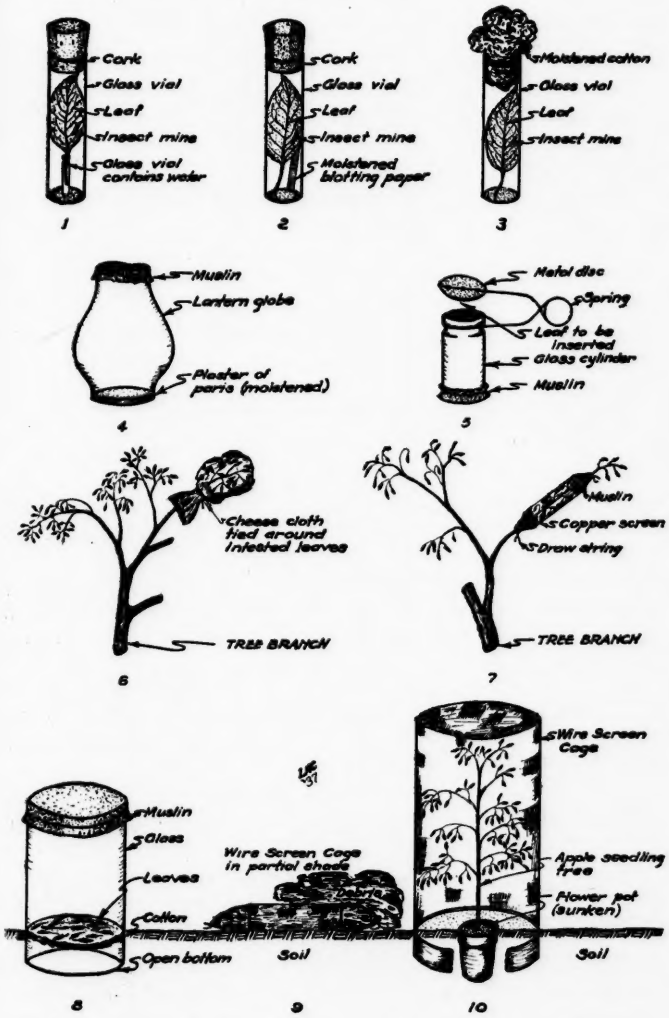

Plate I—Insect Rearing Cages used in Life History Studies of Ornix prunivorella Chamb.

Plate I

1. Double glass vial insect rearing cage.
2. Glass vial insect rearing cage, end closed with cork stopper.
3. Glass vial insect rearing cage, end closed with cotton.
4. Lantern globe insect rearing cage.
5. Glass cylinder rearing cage that clamps on the leaf.
6. Cheese cloth insect rearing cage.
7. Cylindrical wire screen insect rearing cage tied on branch of tree.
8. Glass cylinder insect rearing cage.
9. Cylindrical wire screen cage in contact with the soil.
10. Cylindrical wire screen cage covering potted apple seedling tree.

Plate II

1. Apple leaf serpentine mines shortly after eggs had hatched (Drawn from photograph taken on September 5, 1933). 1x.

2. Apple leaf (a) cross section of mine showing (b) hole where larvae entered (c) section of larva in center (Drawn from photograph taken in July, 1934). 67x.

3. Apple leaf, under surface showing injury by the leaf-mining habit (the mine itself) and distortion of the leaf by rolling and tying (Drawn from photograph taken on July 14, 1933). 2/3x.

4. Apple leaf under surface showing injury by the leaf miner (Drawn from photograph taken July, 1933). 1/3x.

5. Apple leaves upper surface showing injury by leaf mining habit and characteristic location on leaf (Drawn from photograph taken on July 14, 1933). 2/3x.

6. Apple seeding in pot, showing injury of leaves by the leaf mining habit (Drawn from photograph taken in May, 1933).

7. Egg highly magnified (binocular highpower) and showing the grid of cross hairs of the microscope for comparison of size (diagrammatic drawing).

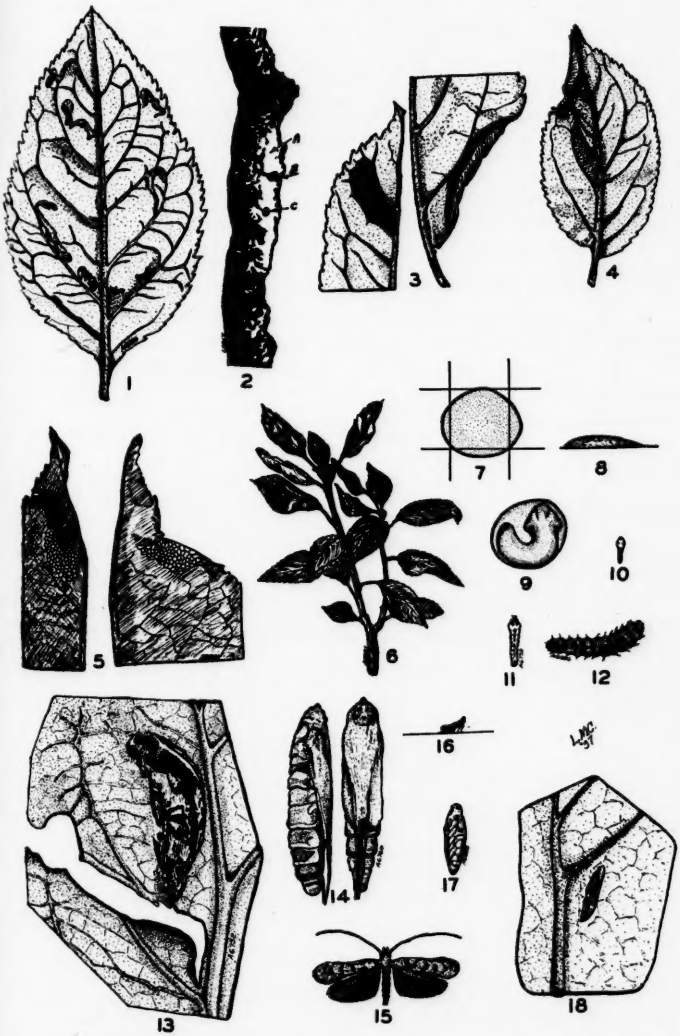

Plate II—Various Stages of Mines of Ornix prunivorella Chamb., and Life Stages of insect.

Plate II (Concl.)

8. Egg showing elevation and how it is firmly cemented around the edges to the leaf (binocular highpower) (diagrammatic drawing).

9. Embryo of insect inside of egg when almost ready to hatch (binocular highpower) (diagrammatic drawing).

10. First instar larvae, showing the likeness to a very small "flat headed borer" (diagrammatic drawing).

11. Larva, slightly shrunken, third moult (Drawn from photograph taken in July, 1933). 5x.

12. Larva, last moult stage (Drawn from photograph taken July 14, 1933). 4x.

13. Leaf unfolded to expose cocoon of insect (Drawn from photograph taken October 6, 1933). 3x.

14. Pupa, dorsal and ventral sides (Drawn from photograph taken October 19, 1933). 7x.

15. Adult Moth with wings expanded showing the feather-like hind wings. 3x.

16. Adult moth at rest and showing its characteristic position when resting or when the insect alights. 1x.

17. Hymenopterous external larval parasite (Drawn from photograph taken July 14, 1933). 4x.

18. Parasite in cocoon (Drawn from photograph taken July 14, 1933). 4x.

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THE SEVENTH ANNUAL INSECT POPULATION SUMMARY OF KANSAS. COVERING THE YEAR 1937*

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The only important change in the method of making the survey and preparing this seventh annual summary was that four pages of drawings with descriptive notes on the insects listed in the questionnaire were sent to the co-operators this year to reduce or eliminate errors which might result from mistakes in identifying the insects.[3]

Questionnaires returned and summarized:

Group I Entomologists in the state: In July—22 In October—18.

Group II County Agr. Agents: In July—89 In October—62.

Group III Farmers, mostly college graduates: In July—18 In October—22

Vocational Agr. Teachers, selected: In July—53 In October—40

Total reports .....July—182 October—142

Grand total of questionnaires summarized 324

In addition to these sources of information, the reports of Prof. H. R. Bryson to the Insect Pest Survey, the annual report and extra surveys of the Extension Entomologist, reports of survey trips through the state and a summary of the department correspondence have been consulted particularly for the "Insect notes" part of this summary.

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**This report embodies results obtained from investigation on Project No. 6.

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(3) References to the previous surveys follow:

1931—Journal Kans. Ent. Soc. 5(3): 65-91. 1 pl. 1932
1932—Journal Kans. Ent. Soc. 6(2):37-59. 1 pl. 1933
1933—Journal Kans. Ent. Soc. 7(2):37-51. 1934
1934—Trans. Kans. Acad. of Sci. 38:171-185, 1935
1935—Trans. Kans. Acad. of Sci. 39:129-149, 1936
1936—Journal Kans. Ent. Soc. 10(4):113-132, 1937

Weather and Crop Conditions in Kansas for 1937[4]

January was the fifth coldest in 50 years with comparatively heavy fall of moisture and a lack of sunshine. The first six days were relatively warm, but an exceptionally heavy fall of sleet on the seventh and eighth covered the eastern and southern portions of the state. Beginning the middle of the month, much of the state was covered with a coat of ice which was made heavier by rain and snow on the thirtieth. Cold waves occurred on January 6, 14, 15, 20, 28, and 31.

February The sheet of ice lasted until about February 20 with more snowfall than usual. When melted, the ice supplied sufficient moisture to put the top soil in good condition and end the dust storms temporarily.

March was abnormally cold and cloudy so that the spring was backward and late. A fair amount of precipitation fell and moisture conditions favored the growth of wheat plants and reduced dust storms in number and severity except in the west. Spring planting was delayed.

April was the driest for 50 years. As a whole, the month was too cool and dry for good growth of vegetation. Since crops were planted two or more weeks later than usual, no material damage resulted from frosts.

May was warmer than usual and was deficient in rainfall over most of the state. The first cutting of alfalfa was generally small, but the season was favorable for wheat.

June had some good rains, but in most sections moisture was inadequate especially in northeastern and eastern central counties. It was a favorable month for wheat, oats, and corn, but the dry hot weather during the latter part of the month was unfavorable for alfalfa, pastures and gardens.

July was characterized by timely though generally inadequate rains with comparatively pleasant weather during most of the month. Threshing wheat and oats was difficult in southeastern counties because of wet weather. Over much of the state, hot weather occurred

4 Largely summarized from the monthly reports of S. D. Flora, U. S. Dept. of Agr. Weather Bureau, Climatological Data, Kansas Section, Vol. 51, Nos. 1-13, 1937.

between rains and became continuous at the close of the month. Pasture grasses and alfalfa deteriorated during the month.

August was the fourth hottest and the eleventh driest in 51 years. It was a severe month for crops, since corn and alfalfa were badly damaged.

September was exceptionally warm and dry over Kansas with about the usual amount of sunshine. Combined with August, the period was the driest two months since 1922. Pastures were in poor condition, corn ripened somewhat prematurely, and alfalfa was left in the poorest condition for many years.

October was deficient in rainfall except in the north-central and northwestern counties. Temperatures were abnormally high during the first five days and the closing week. This was the seventh successive month of deficient rainfall leaving the soil exceptionally dry. The combined rainfall of September and October was only half of the total for these months in 1936. The first killing frost occurred on the fourteenth in the northeastern counties and on the twenty-second and twenty-third elsewhere. By this date most crops had matured. Wheat had a late, unpromising start and considerable reseeding was necessary around the borders of fields because of grasshopper damage.

November was also characterized by deficient precipitation though heavy snowfall occurred in most eastern counties. Temperatures averaged much below normal because of a long severe cold spell the latter half of the month. Temperature and sunshine were near normal, however, in the western part of the state. Wheat in the eastern half of the state improved some because of moisture additions.

December was unusually cold and precipitation was generally deficient. All of the state except some southeastern counties had less than an inch of precipitation during the month. Snowfall was light except in the western portion where one to four inches fell. Heavy coatings of ice were formed on the thirteenth, fourteenth, and fifteenth which were sufficent to break many trees.

In general 1937 was another drought year, the seventh in a succession of sub-normal rainfall. However there were good crops of wheat and oats in all but the west central and western counties, while yields were re-

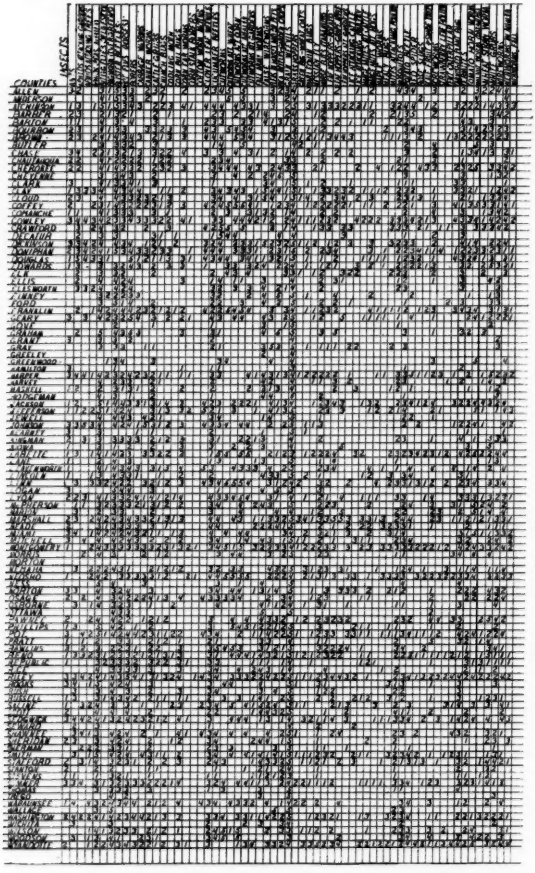
duced in southeastern counties by rust. A fair corn crop was harvested as far west as Saline County. Exceptionally good peach and apple crops and good crops of potatoes, melons, and tomatoes were secured. Alfalfa generally produced only 2 or 3 light cuttings and pastures were poor during the year.

TABLE I - SUMMARY OF WEATHER DATA FOR THE STATE OF KANSAS FOR THE PERIOD September 1, 1935 to December 31, 1937

Month	Temperature					Precipitation (in inches)					
	State Average	Maximum	Minimum	Average for 50 years	Departure from normal	State Average	Average for 50 years	Departure from normal	Eastern third	Middle third	Western third
Sept. '35	69.1°	102°	31°	69.5°	-0.4°	3.17	2.81	-0.36	4.18	3.04	2.29
Oct.	56.1°	91°	17°	57.0°	-0.9°	2.88	1.97	+0.91	4.96	2.22	0.58
Nov.	40.2°	75°	3°	43.3°	-3.1°	2.31	1.31	+1.00	3.86	2.07	0.99
Dec.	33.8°	65°	-3°	32.8°	+1.0°	0.27	0.85	-0.58	0.43	0.23	0.16
Jan. '36	26.3°	70°	-21°	29.8°	-3.5°	0.71	0.66	+0.05	1.13	0.66	0.34
Feb.	22.2°	84°	-23°	32.9°	-10.7°	0.23	1.00	-0.77	0.45	0.17	0.08
Mar.	48.5°	90°	9°	43.3°	+5.2°	0.14	1.42	-1.28	0.24	0.06	0.11
Apr.	54.5°	98°	-2°	54.7°	-0.2°	1.17	2.56	-1.39	1.69	1.01	0.81
May	67.7°	99°	36°	63.8°	+3.7°	4.88	3.80	+1.08	4.90	4.44	5.29
June	77.3°	114°	44°	73.8°	+3.5°	1.26	4.00	-2.74	1.30	1.42	1.07
July	85.7°	121°	50 °	79.0°	+6.7°	0.86	3.20	-2.34	0.83	0.83	0.93
Aug.	85.3°	119°	47°	77.6°	+7.0°	1.06	3.13	-2.07	0.92	0.95	1.32
Sept.	72.5°	107°	31°	69.6°	+2.9°	4.84	2.86	+1.98	7.38	4.93	2.21
Oct.	55.8°	92°	12°	56.9°	-1.7°	1.82	1.96	+0.15	2.44	2.07	0.94
Nov.	43.1°	80°	7°	43.3°	-0.2°	0.18	1.29	-1.11	0.49	0.04	0.02
Dec.	37.7°	69°	-1°	32.9°	+4.8°	0.86	1.16	+0.30	1.86	0.99	0.62
Averages or totals for 1936					+17.9°	18.01	27.04	-8.14	23.63	17.57	13.74
Jan. '37	21.3°	63°	-20°	29.6°	-8.3°	1.40	0.67	+ .73	2.33	1.47	0.39
Feb.	32.7°	75°	-11°	32.7°	0	.68	.99	- .31	.95	.71	.37
March	40.0°	77°	0	43.3°	-3.3°	1.65	1.42	+ .23	2.59	1.50	.86
April	54.3°	98°	15°	54.7°	- .4°	1.00	2.53	-1.53	2.04	.57	.39
May	66.7°	102°	32°	63.8°	+2.9°	3.15	3.78	- .63	4.06	3.96	1.44
June	74.3°	109°	38°	73.8°	+ .5°	3.27	3.98	- .71	3.59	3.18	3.03
July	81.7°	113°	52°	79.0°	+2.7°	3.14	3.20	- .06	3.97	3.76	1.70
August	83.5°	113°	52°	77.7°	+5.8°	2.06	3.13	-1.07	2.43	2.17	1.57
Sept.	71.3°	106°	30°	69.6°	+1.7°	1.90	2.83	- .93	2.38	2.05	1.27
Oct.	57.2°	96°	18°	57.0°	+ .2°	1.43	1.95	- .52	1.49	1.59	1.22
Nov.	41.0°	87°	- 2°	43.2°	+2.2°	.67	1.27	- .60	1.26	.60	0.15
Dec.	31.8°	73°	- 8°	32.8°	-1.0°	.53	.85	- .32	.92	.38	.29
Aves. or totals 1937					- .2°	20.88	26.54	-5.66	28.01	21.94	12.68

Since the table of weather data for 1936 was omitted in last year's summary, it is included here.

Plate I. Insect summary from questionnaires returned in July and October for all of the counties of the state except Morton.



The more striking insect activities and climatic relationships for 1937.

Ants (Formica sp.) were exceptionally plentiful during September and October and many specimens were sent in as possible termite invaders. The winged forms swarmed out of nests around porches, trees, stumps, cellar windows, and in basements.

The **yellow ant** was fully as abundant from March to June in basements of homes and on the outside of foundation walls as usual. This species appears to be on the increase.

The **mound building ant** made larger mounds and more of them during 1937 than in 1936 and were unusually active in alfalfa fields.

Apple curculios were scarce in northeast Kansas during the spring of 1937 according to Dr. R. L. Parker.

Aphids in general were not particularly plentiful during 1937. The **cabbage aphid** reached damaging numbers on cabbage in Riley and other eastern counties in May. **Spiraea aphids,** probably **(Aphis spiraecola** Patch), appeared on the new growth in early June in normal numbers. The **elm leaf aphid** again reached outbreak proportions the latter part of May in the eastern half of the state. Honey dew was dropped on cars parked under elm trees and muscoid flies were attracted to it. Cars with tops covered with bluebottle flies were seen between May 28 and June 21 when rains washed the honey dew from the elm foliage. Dust and cotton from cottonwood trees settled in the honey dew making the grass and shrubbery unsightly. The extension entomologist estimated that there were several thousand moths of **Plusia simplex,** the army worm and variegated cut worm moths around his car at Tonganoxie on June 17th while it was parked under an elm tree. A black fungus grew in the honey dew causing low vegetation and water in fish pools to become black. By the latter part of June, aphid enemies such as lady beetles, chrysopids and syrphid fly larvae were able to terminate the outbreak. Healthy elms did not develop the peculiar yellowish or salmon colored foliage which often presages their early death.

Pea aphids were not found in alfalfa fields until April 10. The cold, backward spring apparently delayed their advent. Alfalfa made little growth before mid-April. Pea aphids were particularly scarce during the

previous summer and fall so the season began with an abnormally low population.

By May 12, pea aphids occurred in small numbers in most alfalfa fields of the state but the new growth was then knee high and aphid predators were plentiful.

By May 19, pea aphids had built up to 20 cc. or more for 25 sweeps of a net in Riley county. There was also an extremely large population of syrphid larvae. They were more plentiful than lady beetles. Aphids reached a balance with other environmental conditions near alfalfa blooming time and no reports of injury were received.

By June 6, pea aphids were scarce in the fields. Only occasional adults could be found on alfalfa and vetch. Peas were dusted by the Columbus Foods Co. at Lawrence where damage to peas occurred. The small population of aphids decreased rapidly from June 10 to July 20 when only occasional ones could be found. However no pea aphids could be found in the state after July. They were completely absent during the fall.

Alfalfa stands were at a low point in the state for 1937. There were few young stands, most stands being 3 or more years old and they were thin and grassy.

The **rusty plum aphid** began to appear in considerable numbers on plum and peach trees in Riley county about May 18 but they were soon decimated by predators. They were abundant in the fall on grasses of the genus **Eragrostis** according to Prof. D. A. Wilbur.

Radish aphids were more abundant than usual during May in Riley county.

Some **greenbugs (Toxoptera)** were reported in early spring on wheat and oats, but they confined their damage to near Enid, Okla. No injury was seen or reported.

The **corn root louse** was reported abundant near Topeka in May.

Army worms occurred in a wide spread outbreak in southern and eastern Kansas during June. They were first reported along the Oklahoma border. As usual, these larvae were most plentiful in grassy plots, grass land, wheat and garden crops. The use of bran mash for control was hampered by rain. About 30 percent of the larvae were parasitized. A large population of moths occurred at lights during July. The high summary num-

bers in southeastern Kansas counties for cutworms attacking wheat, corn and alfalfa reflect primarily the large population of army worms in that region.

Wheat head army worms also called "barber worms" attained damaging numbers in early June in the eastern half of the state. This and army worms ate the beards and glumes off heads of wheat and rye particularly in Elk, Montgomery, Wilson and neighboring counties. It was reported that these larvae also climbed fruit trees and ate foliage.

Fall army worms occurred widely in the state but many population numbers reported for this species were too high in the opinion of the authors These were reduced because it is believed there was some confusion as to the species seen. No important damage was seen by the authors nor was any reported.

Blister beetles first appeared in alfalfa fields about the middle of May. Small gray species became exceptionally plentiful by early June and damaged alfalfa blossoms by eating the petals. By mid-June, damage to foliage of apple seedlings in the Kaw valley was reported. They reached damaging numbers in gardens by the last of July. There was a succession of species with more than ordinary numbers until early October. The outbreak, while wide-spread, was not severe. The large population reflects the large number of grasshopper eggs upon which the larvae feed and the favorable effects of the dry weather.

Box elder bugs began reaching the adult stage in Riley county on June 24. Many eggs were deposited on the bark and flowers of maples. The young nymphs fed on the seeds and clustered on the trees for the first time in nearly 5 years. The numbers indicated a return to a normal population after reaching nearly zero in 1934 and 1935. They went into hibernation around homes in Manhattan in sufficient numbers during October to cause annoyance.

Bees wintered well where stores were sufficient. The weather was too cold and wet in early April to allow normal flight during the blooming of maple, elm, and willow. However they had good flying weather during the fruit blooming time. A shortage of sweet clover due to the drought caused some beekeepers to quit and others to move from the state. Bees were not

maintaining weight until they began collecting nectar the last of July from Spanish needle in southeastern Kansas and smartweed in the eastern half of the state. American foul brood was prevalent during the dry, hot summer. Some beekeepers reported a fair yield of honey from bloom in late summer.

Borers especially the flat headed apple tree borers continued about as prevalent as last year judging by correspondence and observations on trees. They are attacking practically all kinds of trees and many shrubs such as spiraea.

Professor G. A. Dean reported several adults of the 4 spotted **hickory borer (Eburia quadrigemminata)** emerging during the year from oak floors in houses and an instance of one emerging from an oak desk several years old.

Cabbage looper (Autographa sp.) moths were exceptionally plentiful in May and June at flowers in the evening and at honey dew. Several species occurred but the larvae of these moths were not particularly common on alfalfa, cabbage and wild lettuce.

Cabbage curculio adults did serious injury to cabbage during June. They gathered around the margin of the leaves and punctured them causing the edges to turn brown and wrinkled.

They damaged or destroyed sweet Alyssum in Riley and Saline counties the last of June according to Prof. G. A. Dean.

Cankerworms were scarce over almost all of the state during the spring of 1937. Many trees were banded in Riley county and elsewhere but only an occasional canker worm moth was caught on the bands. The population of this insect is at the lowest point for 10 to 15 years.

However, a few elms during May showed some cankerworm injury to leaves near the trunks of trees. Larvae were about half grown by May 20. It was reported that some elm trees at Westmoreland and south of Manhattan were entirely stripped by cankerworms.

Carrot beetles (Ligyrus gibbosus) was unusually plentiful at lights all year. Injury to root crops, zinnias, marigolds and other flowers was reported from Spearville.

Cattle grubs probably declined somewhat in population in the state during 1937 largely because of the decrease in the number of cattle in western Kansas. There are now few cattle from Ellis county west to the Colorado border. There are fewer cattle infested and the average infestation is lighter than in 1936.

Chinch bugs were the scarcest in years. There probably was not a mile of barrier built in the state in 1937. The bugs did not survive the severe winter in their inadequate hibernating quarters. While weather was favorable for them, they failed to build up until late summer. Timely rains probably destroyed the greater part of the bugs of both generations in their early stages according to W. T. Emery. There was only a small population in hibernation during the close of the year. The summary numbers indicate a most unusual picture for the state, though some injury was reported at Parsons.

Chrysopid adults, especially **C. plorabunda, C. oculata,** and **C. rufilabris** were exceptionally plentiful during the summer and early fall of 1937. They came to porch and street lights by thousands. Never have the writers seen them so plentiful. The larvae did not appear to be abnormally plentiful in gardens and alfalfa fields. It is believed these insects assisted materially in reducing chinch bugs and aphids during the growing season.

Some **17 year Cicadas** were heard in the region from Independence, Kansas north to Lawrence early in July. While the great majority of the cicadas singing in the wooded draws were the common one or two year species, the songs of some periodical cicadas were recognized. No adults were taken, however.

Clover leaf weevils were more numerous than last year and reached about normal numbers in alfalfa fields during the spring. They were plentiful in Riley county and some damage was reported from Leavenworth county the middle of May. Injury chiefly by adults sufficient to retard the second growth in early June was reported at Tonganoxie.

Corn bill bugs were not plentiful and caused no serious damage in 1937. They were present in areas 1. 2, 5, and 6b.

Crambids or sod webworms and moths were excep-

tionally plentiful in grass lawns and around lights in September and early October. Lawns were damaged at Atchison. The source of the exceptional numbers observed was not known.

Black Crickets were more destructive and numerous in homes, in Kansas during 1937 than for many years. By early August, the common black cricket was a great annoyance practically all over the state. The hot dry weather drove them to basements. They continued to be annoying until about October 1st. Hedgeballs were recommended by some communities as valuable repellents against them, but no evidence of their effectiveness is at hand.

Colorado potato beetles were scarcer than usual during the spring. The first generation which was abnormally light completed its development the last of May.

Corn ear worms were present in usual numbers or more thoughout the season. Practically all ears of field corn showed some injury by them. They caused less than usual injury to the curl of corn and some injury to the fruit of tomatoes in eastern Kansas. The population in alfalfa fields during the late summer and early fall was less than normal. During the fall, they attacked sorghum heads. They were more numerous throughout eastern Kansas than for several years.

Cutworms varied in population during 1937, some species being scarce and others occurred in outbreaks. The **army** cutworm was numerous only in the western part of the state in pastures according to Mr. H. H. Walkden, but no damage to cultivated crops was seen or reported. The **dingy** cutworm was the most plentiful early species but the population of this species was low compared with previous years. It occurred in largest numbers in grass plots, pastures, alfalfa fields and under trash. They developed slowly because of the cold late spring and matured somewhat later than usual.

The **pale western cutworm** occurred in the most destructive outbreak ever recorded in Kansas in several western counties in 1937. They became fully grown about the middle of May and aestivated. They were found in a stubble field of a section of land in Rawlins county on May 7. A survey by Mr. H. H. Walkden showed them to be numerous in Ellis, Rush and Meade counties. Summary numbers of cutworms attacking

wheat in Rawlins, Decatur, and Thomas counties refer also to the pale western cutworm. This species did not occur on summer-fallowed land which indicates a method of control for future years.

There was a definite widespread outbreak of **variegated cutworms** during early June in alfalfa fields and garden in eastern and southern counties of Kansas beginning early in June and extending as far west as Osborne county. A few larvae of this species were received May 18 from southern Kansas which was the time that the outbreak of army worms was developing. The damage was severe in many communities. Growth of alfalfa following the first cutting was prevented. Reports of as many as 30 larvae to the square foot were received. The larvae were mostly grown by June 10. Rains in the infested areas interfered with bran mash sowings. Some cutworm damage to alfalfa fields in the Kaw Valley was observed in mid-July.

Cutworm moths began appearing at lights about May 20. They were found in large numbers by the middle of June, and continued plentiful to the last of July, the variegated reaching a peak the last of June and in early July. **Autographa** and **Caenurgia** moths made up the majority of them. Hordes of moths were reported during this period from Arnold and Tonganoxie, Kansas. The moths clustered on orchard grass infested with leaf hopper nymphs and on aphid infested elms for the honey dew deposited there by these insects.

During the last of July, **cotton cutworms** became plentiful. Some injury to tomatoes and sweet corn by this species was observed.

Clover root curculios (Sitones hispidula) were more plentiful in the state than for possibly five years. This species practically disappeared after a peak population about 1929, but it is building back to normal numbers. There were almost normal numbers in Riley county in 1937. Damaging numbers of adults and larvae were seen and reported in Wabaunsee county early in June.

The **diamond backed moth (Plutella maculipennis)** occurred in large numbers in all northern counties from Marshall to Phillips counties during May, being a feature of the spring of 1937. The larvae fed on pepper grass or "bird seed grass" and pupated on such nearby plants, as alfalfa and wheat but did not feed upon these plants.

The moths were common at lights from the middle of May through June.

Eight spotted forester moths attained in the late spring the largest population seen in the state for several years. The moths occurred especially at flowers while the larvae caused injury to Virginia creeper and both wild and cultivated grape foliage. Injury by this species was reported from Riley and Doniphan counties.

False chinch Bugs (Nysius ericae) were numerous in September on purslane in Riley and perhaps other counties.

Flea beetles were conspicuously absent in gardens during the spring. No injury from them was seen nor reported.

A statewide outbreak of **biting flies** on livestock occurred in Kansas during early August, following the July rains. They bred in the trash accumulated by high water along creeks. Some dairies at Independence dropped 50 percent in milk production. Farmer's deductions from seeing dead flies in bait mixing plants resulted in a serious newspaper blunder of recommending spraying cattle with sodium arsenite to kill attacking flies. Such sprays caused the death of some animals and serious injury to others. The outbreak of flies was over by September 1.

There was a slightly less severe outbreak of biting flies in the Kaw valley during the last of May. Riley county cattle were heavily attacked. By the first of June, many letters asking for repellent spray formulae had been received and dealers reported being sold out of pyrethrum extract.

Screw worm flies were fairly active again during 1937 and were reported attacking cattle, hogs, and other animals in 22 counties. Pasture cattle and new born calves were attacked most severely in the following counties and after the name is given an estimate of the number of farms reporting these pests: Barber, 375 farms; Butler, 350 farms both largely in cattle from Texas: Ellis, 150; Comanche, 60; Greenwood, Leavenworth, Elk and Pawnee, 50 each; Pottawatomie, 25; Woodson, 24; and Ottawa, 15. These pests also occurred in Jefferson, Osage, Chase, Cowley, Labette, Pratt, Rice and Riley counties. A total of 2641 animals were treated in the state for screw worms with no animals lost.

Blue bottle flies and closely related forms swarmed on May 20, in northern counties feeding on honey dew dropping from elms. It was thought that the large population of flies may have developed on dead grasshoppers last fall.

Encephalitis which is presumably a **mosquito** borne disease attacking horses, occurred in the largest outbreak in Kansas since 1912 throughout September to near the middle of October. State authorities estimated that between 4000 and 5000 cases occurred during this period about 50 percent of which terminated fatally.

Forage loopers (Caenurgia erechtea) was somewhat more plentiful than last year though the population of larvae in alfalfa fields in eastern Kansas was graded as average. Moths came to lights in greater numbers than usual during the summer and the larvae were more plentiful in September and October than for several years.

Grasshoppers occurred in a severe statewide outbreak again in 1937 though in general it was stated that the grasshopper population was slightly smaller than in 1936. The grasshopper population for 1937 was close to that predicted from fall surveys. Hatching began on May 10 in Riley, but it occurred earlier in southern Kansas. Comanche county was about two weeks more advanced than Riley county. The first adult migratory hopper was seen on May 31. The infestation in early June appeared spotted, being heavy in some places and light at others. By June 11, the hoppers were 1/3 to 1/2 grown. No fungus disease was found any place in the state. By June 14. hopper dozers were being used and extensive bait sowing campaigns were under way. About half of the migratory hoppers were then adult, and a second large generation of eggs was deposited. Poison bait sowings gave good kills even when sown for cutworms. The second generation of migratory hoppers began to appear about June 20, though some of the early small ones were probably from overwintered eggs.

The injury in eastern Kansas to sweet clover was marked. Most clumps were defoliated or barked. Alfalfa was the next most severely injured plant and corn next. The population appeared to be fairly uniformly distributed over the state but it was somewhat smaller in southeastern Kansas during the last of June. In Rooks county, grasshoppers destroyed the second growth of

wheat or late germinating wheat leaving the dry matured stalks to be cut or harvested.

There was a heavy parasitism of 20-30 percent by Sarcophagid flies during the summer. Horse hair worms (Mermis) were more plentiful than for years, the infestation being as high as 35 percent while mites on the wings occurred on 20-40 percent of the hoppers.

During early August, most of the second generation nymphs were out and throughout most of the state, alfalfa was more severely damaged than corn. Reports of flights were regarded as fictitious. There was more vegetation, especially weeds, than during 1936 which served to help keep them out of crops and furnished sufficient food for maturing a large healthy population.

Epsom salts were recommended in newspaper articles as an adequate substitute for arsenic and were widely used for making baits with unsatisfactory results. Tests showed that the material was without value for the purpose.

Late summer damage centered especially on corn. In some sections, corn was practically destroyed. In Riley county 10-60 percent foliage damage was common but a fair crop of grain was produced.

The weather from September to early November was most favorable to maturing nymphs and egg deposition. The 1937 fall deposition of grasshopper eggs was the largest ever found in the history of the state. Many grass clumps had as many as 10 or more capsules in them. Egg deposition continued until the abnormally severe cold spell beginning on November 14, killed the adults. The smaller species lived longer than the larger ones or differential and two-lined. The appearance of small nymphs in late October suggested the possibility of a partial third generation of **Chortophaga viridifasciata.** Fungus or other diseases never appeared during the season but parasites, hair worms, flies, mites and blister beetles continued to be more plentiful than usual throughout the fall.

A feature of the year was the marked eastward spread of the southwestern **lubber grasshopper.** For the first time in years it was fairly common in Riley and Wabaunsee counties. It fed on sunflowers and coarse weeds along creeks, roads and shaded areas.

The following quantitative information from the 1937 outbreak is given for further insight into the grasshopper population and damage for the season: 103 counties carried on grasshopper control; 611 hopper dozers were built in 78 counties and were used to treat 9,294 acres of grassland in 29 counties and 19,391 acres of alfalfa in 72 counties. The Federal government supplied 104,813 gallons of sodium arsenite while the total used from all sources was 139,242 gals. There were 3,273,000 lbs. of "mill run" and 7,122,166 lbs. of sawdust used in making a total of 26,822,480 lbs. of wet bait which was used by 75,246 farmers. Kansas farmers spent $77,151 on bait and the government $85,000. A total of 3,352,606 acres were treated one or more times with poisoned bait of which 1,186,060 acres were in wheat, 875,942 acres were in corn, 230,980 acres in alfalfa and other legumes and 346,845 in grassland. Bait was used in 43,631 gardens or 32,868 acres and 876 orchards of 8,315 acres.

The damage done may be summarized as follows:

Number acres wheat slightly damaged **2,183,186**;
destroyed ..... 104,925 Acres

Number acres oats slightly damaged **285,900**;
destroyed ..... 15,870 Acres

Number acres barley slightly damaged **101,245**;
destroyed ..... 55,075 Acres

Number acres corn slightly damaged **776,400**;
destroyed ..... 163,992 Acres

Number acres alfalfa slightly damaged **277,349**;
destroyed ..... 64,027 Acres

Number gardens damaged 58,161

Number orchards damaged 3,889

Grain weevils apparently increased in population in 1937 over either 1935 and 1936. Dr. R. T. Cotton reported that "Inspection records of grain arriving on the Kansas City market during the period of July to December indicated an increase in weevil infestation. During the preceding season less than 1 percent of cars of wheat arrived on the Kansas City market graded weevily whereas in October and November of this year nearly 4 percent were graded weevily."

Green Clover worms were slightly more plentiful than normal. There is, however, generally a large population which often does noticeable injury.

Hessian fly over all the state had in 1937 the smallest population in years. This insect did not materially affect the yield of wheat anywhere in the state.

Fall wheat was sown generally without regard to the safe seeding date. Some sections sowed in August. The fall was dry and wheat was slow in coming up. The fall survey showed a maximum population of about 13 percent of stems infested in all but northwestern Kansas which had none. Examinations in central Kansas on October 26 showed that many wheat stalks which had come up early were infested with fly while stalks which came up just after the October showers were not infested. The year closed with Hessian fly building up in numbers due to late egg deposition. The summary map presents a most unusual picture for the state.

Imbricated snout beetle was reported damaging melons in Johnson county during May. Grass was injured by this species and another snout beetle (Sphenophorous) in Riley county according to observations of Prof. D. A. Wilbur.

Leaf hoppers of three or four species came in great numbers to lights during September and October and caused damage on apples (especially in Doniphan county), some shade trees, grapes, woodbine, and some garden plants. By early October, serious damage occurred on apple and woodbine in the eastern part of the state. Leaf hoppers continued abnormally plentiful until late October. They occurred in great numbers on elm. oak, and sycamore in Riley and neighboring counties.

Both **chewing** and **sucking lice** on domestic animals were somewhat less numerous and destructive than during the last two or three years. There were few reports of infestations received during the spring.

Mites (Petrobia tritici Ewing) were reported in destructive numbers in wheat fields near Salina on April 19. Infested fields or spots in wheat fields appeared yellow as if suffering from lack of moisture. An examination revealed all stages of the mites present. The mites at the same time occurred in destructive numbers in Oklahoma and Texas. The hot dry period during the last of March and for three weeks in April favored their increase. This

species of mite also occurred from Clark and Meade counties west to Liberal and the mite with the dry weather destroyed considerable wheat. It did damage in Meade, Stanton, Morton and Stevens counties and helped reduce wheat fields of some 500 acres virtually to a desert and was referred to as the "dust bowl" mite. The green wheat turned reddish resembling cured hay. The plants lie flat and the color is characteristic of the injury.

The **clover mite** occurred in small numbers in southwest Kansas in April. The common **red spider** occurred on columbines, beans, and evergreens, but not in great numbers. This species did less damage to evergreens than would be expected in a hot dry year.

Some other mites were also more plentiful than usual during 1937. **Eutrombidium locustarum,** the grasshopper mite was exceptionally plentiful all over the state. Overwintering adult mites were seen in Dickinson, Brown, Jackson, Phillips and Ellis counties feeding on grasshopper eggs in March. Later these mites were found in all the eastern counties crawling over the ground and their presence was used as an indicator of the location of grasshopper eggs. The mites deposited their eggs near grasshopper egg beds.

Mites were exceptionally numerous on grasshopper wings all season. They were the subject of considerable newspaper publicity in the state overemphasizing their importance. The nymphs left the grasshoppers in August and early September and adults were seen crawling on the ground going into hibernation.

Mites (red spiders) were bad on elm foliage during the latter part of the summer especially in the central and much of the eastern half of the state. Injury was done by red spiders to beans, flowers, shrubs, and vines from June to September.

Monarch butterflies were first seen in eastern Kansas June 15 and in Riley county on June 21. The wings were frayed.

Negro bugs were observed in large numbers in Riley county on annual violet in early May. This was the third successive year that this species was plentiful. They caused injury to snapdragons, daisies and coreopsis plants at Manhattan.

The **onion plant bug (Labopidea allii** Knight) which was reported for the first time in Kansas in the summary

for 1936, assumed outbreak proportions in Riley county and the Kaw valley during May. The adults and nymphs clustered on onion stalks causing the tips of the stalks to turn brown and many leaves to die. The bugs are active, therefore difficult to control by spraying. Outbreaks on onions were reported from many places around Manhattan, also in Mitchell, Marshall, and Doniphan counties. By June 5, the bugs had largely disappeared. The injury to onions was somewhat overcome by timely rains though many patches of onions were killed. Nothing controlled the bugs successfully.

The **red bud leaf folder** was exceedingly abundant in Riley county all season. It built up to outbreak numbers in all eastern Kansas counties and the third generation folded practically every leaf on red bud trees. The population was as high as in 1934.

Scale insects were reported plentiful in Manhattan on old cedar trees by Mr. R. G. Yapp.

Evergreens on the college campus in Riley county were heavily infested with a scale insect (**Cryptaspidiotus shastae** Coleman) which in early September was highly parasitized by a small chalcid (probably a Trichogramma). The scale is favored by dry, hot conditions.

The **rose slug** was less abundant than for several years. Some injury to rose foliage however occurred in May and June. It was reported from Montgomery, Jewell, Riley, Brown, and Doniphan counties.

Seed corn maggots were more plentiful and destructive than usual during April and May of 1937. Reports of injury to corn, kafir, melons, and beans were received in May. Anderson, Phillips, Jewell, Riley, and Franklin counties reported injury. Replanting of corn was necessary in some fields. Seed germinated slowly due to wet, cool weather. These are the conditions which favor this pest.

Sphinx drupiferarum (A & S), the wild cherry sphinx, a medium sized black and white sphingid moth was exceptionally plentiful in Riley county. The species was not in the college collection before, but practically all sphingids in student collections during May were of this species. It is perhaps a western species which has come in as a result of the drought. The moths were still plentiful at lights at mid-June and at flowers in the evening.

The **strawberry leafroller** was less abundant in Doniphan county during the spring than for the past two years according to Dr. R. L. Parker. However, the species was abundant and destructive in several counties as shown in the summary table.

Squash bugs were again plentiful from June to October. They were more destructive to pumpkins and squashes than for several years. The dry hot summer weather favored them.

Tarnished plant bugs reached outbreak proportions in the fall when damage was done to late potatoes, nursery stock, alfalfa, gardens and some flowers, especially Chrysanthemums. These insects appeared early. The first generation ended about May 19 in Riley county. The second generation appeared about the last of June and the third from September on. The fall population was the largest for several years in Wyandotte, Johnson, Douglas, and Riley counties. Serious damage was done to late potato foliage in a few fields. Tarnished plant bugs went to alfalfa fields for overwintering in early October in large numbers.

The **walnut datana** defoliated walnut trees more or less completely in July and August in eastern and southeastern Kansas. The outbreak was particularly severe around Independence. The population was no more than normal in central Kansas. The **sumac datana** defoliated sumac in Riley county in September.

Termites were late in swarming because of the cool, wet, late spring. Up to April 10, only two swarmings were observed at Manhattan. Activity in buildings was reported to the usual extent from early March. They swarmed again in Riley county on May 12, and 17. They were plentiful under boards and in stumps on May 19, but soon disappeared from these places. One small swarm was seen October 17, following 1.75 inches of rain.

The **unspotted tentiform leaf miner (Ornix prunivorella** Chambers) was abundant and destructive in Doniphan county all season according to Dr. R. L. Parker. It was first found there in 1934, and in the college orchard 1931-32 (but identified 1933). This species is favored by drought and increases during the season reaching largest numbers in the fall.

Garden web worms first appeared in outbreak num-

bers on small corn in Riley and Dickinson counties. This early damage in June was done by the first generation. The moths of this species were plentiful at lights during the summer but the larvae did not reach damaging numbers until the third generation the latter part of August, when damage occurred to young alfalfa from Sedgwick county east. This species was plentiful during August at many points in the western half of the state but cutting infested alfalfa promptly appears to have handled the situation. Some harrowing of fields was also done to destroy the pupae. Larvae and moths persisted in Riley county until the last of September.

False wire worms were plentiful during the fall and winter of 1936 but little damage was done. They continued plentiful in the spring of 1937 and built up to damaging numbers due to favorable weather in 29 counties in areas 6a, 6b, 7, 9, and 10b. Severe losses from this insect resulted in southwestern Kansas. Where wheat was sowed in dry ground over 1,000,000 acres were reported destroyed. Elsewhere the stands were left thin. False wireworms occurred as far east as Riley county, and damage was reported in Saline county. No large population nor serious injury was observed east of Clay county though adults of several species were common farther east. This species damaged watermelons in Barton county in June.

The **wheat saw fly** occurred more plentifully in wheat during early April than was ever known. It was found from Riley west and south of Ellsworth and McPherson counties. No perceptible damage was done to wheat. The larvae were heavily parasitized. They had largely pupated by June 10.

The **wheat straw worm** was scarce in all parts of the state.

Thrips were common during April and May on alfalfa and wheat. They reached about normal numbers during June on alfalfa and flowers in general.

Wasps (Polistes) were exceptionally plentiful in Riley county during October.

White grubs were moderately abundant in Kansas during the spring of 1937 and plentiful during the fall in areas 6b, 9, and 10c.

Wheat white grubs (Phyllophaga lanceolata) appeared in damaging numbers during June in Riley and

Harper counties on golf courses and grassland. The adults were heavily parasitized by a Sarcophagid fly according to Prof. H. R. Bryson. During the fall this species occurred in severe outbreak in about eight southcentral counties and somewhat less in 4 others. It is estimated that 400,000 acres of wheat were damaged or destroyed in the fall of 1937. This area included Harper, Barber, Comanche, Edwards, Kiowa, Pratt, Kingman, Sumner, Harvey, Marion, McPherson, and Reno counties. There was damage as far north as Riley, and Clay counties. Some fields were reseeded as often as three times and still failed to get a stand. The larvae ate off the roots and the plants quickly withered. The wheat white grub does damage in the odd numbered years because it has a two year life cycle. The heavily infested area extends into Oklahoma. The dry weather has extended northward the range of this pest.

Wireworms reached damaging numbers in southeast Kansas during the spring. Wheat was damaged at Wichita. The unfavorable soil conditions which retarded germination of seed favored damage. Corn and wheat were reported damaged in Wyandotte and Cherokee counties.

SUMMARY AND CONCLUSIONS

In general, 1937 was a record breaking drought year with an abnormally hot summer and winter months below normal temperature. The year's rainfall was deficient everywhere except in a few counties in southeast Kansas. Each of the last nine months was drier than usual. It was a year of more than usual insect populations and insect damage.

The following insects occurred in **outbreak** during 1937: elm leaf aphid, army worms, blister beetles, borers, cabbage curculio, black crickets, pale western cutworm, variegated cutworm, biting flies, grasshoppers, leaf hoppers, onion plant bug, red bud leaf folder, tarnished plant bug, walnut datana, garden web worm, false wireworm, and wheat white grub.

The following insects in addition to those mentioned in outbreak were **more plentiful** during 1937 than during 1936: formica ant, pea aphid, cabbage aphid, rusty plum aphid, radish aphid, wheat head army worm, fall army worm, box elder bug, cabbage looper, and curculio, carrot beetle, clover leaf weevil, cotton cutworm, dingy

cutworm, clover root curculio, crambid moths, diamond back moth, eight spotted forester, forage looper, grain weevils, corn ear worm, false chinch bug, green clover worm, imbricated snout beetle, screw worm flies, mites on wheat, clover and grasshoppers, negro bugs, red spider mites, onion plant bug, seed corn maggots, wild cherry sphinx, squash bug, tentiform leaf miner, wheat sawfly, white grubs, and wireworms.

The following insects were **scarce** or **nearly absent** during 1937: apple curculio, cankerworm, chinch bug, Colorado potato beetle, army cutworm, flea beetles, Hessian fly, and rose slug.

The following insects in addition to those mentioned as scarce were **less plentiful** than in 1936: cattle grubs, corn bill bugs, chinch bugs, rose slugs, and strawberry leafroller.

The following insects had **about the same population** as in 1936: yellow ants, mound building prairie ant, borers, corn ear worms, army cutworms, feltia cutworms, grasshoppers, termites, thrips, and scale insects.

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